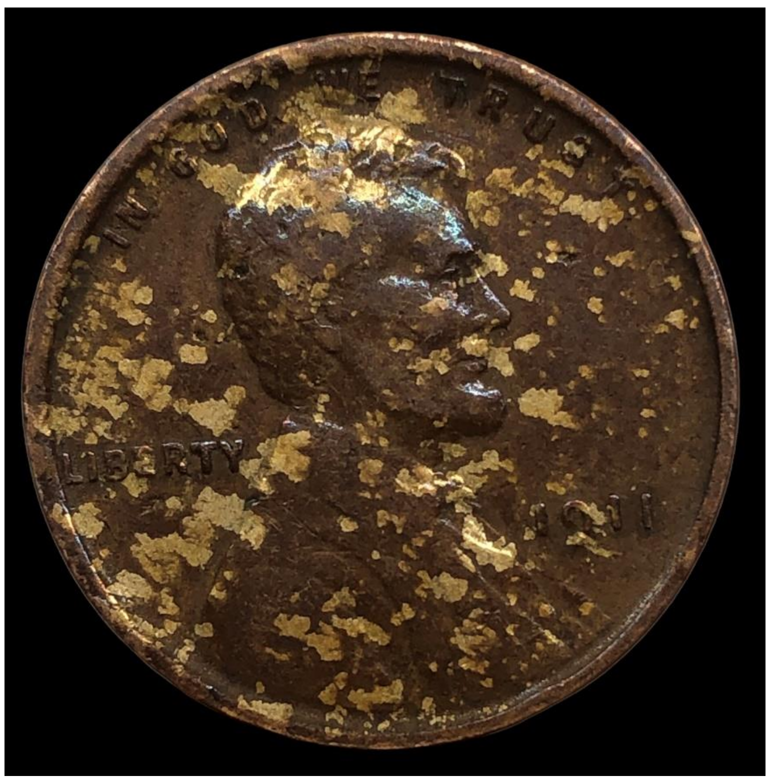
The Rabbit Hole

of

Improper Alloy Mixes

An amateur collector's journey.



Written by Shawn Tew

Edited by Pete Apple

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Dedicated to my biggest supporter

My wife

Sarah Tew

And to my children

Without them I would not be here and have the life that I have.

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THE

RABBIT HOLE

RESEARCH GROUP

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To my favorite and only tech at Michigan State University's Center for Advanced Microscopy, Amy Albin. Your knowledge in helping find the information needed for this project will help those reading understand what happened over a century ago. Pete Apple, thank you so much for your time and energy in this project and taking on the editing and flow of the book. Joe Cronin, thank you for your advice and guidance in this project. To my fellow numismatic collectors in The Rabbit Hole Research Group thank you for the open ended conversations over the past year.

PREFACE

I began collecting when I was around seven years old after seeing my grandfather's collection. For years I would come and go in the hobby, buying for a brief period and then it would get packed away as life changes came and went. In 2019 I picked it up again. The COVID years of 2020 and 2021 brought on a different aspect of life. I became interested in the unusual and turned to improper alloy mixes and became curious about how they occurred. Over the next year I collected examples and investigated various possibilities for their composition. Follow me as I explore this phenomenon and the errors that are often overlooked and discarded.

TABLE OF CONTENTS

INTRODUCTION

As the once normal phenomenon known as alloy mix errors began to fade with the advancement in techniques and technology we look back and explore the metallurgical breakdown of what that phenomenon is and the resulting errors that occurred because of it.

WELCOME TO THE RABBIT HOLE………

CHAPTER 1

Metallurgical Composition of US Coinage

The following is the metallurgical composition of US coinage from 1793 to present.

Copper (Cu) Silver (Ag) Nickel (Ni) Zinc (Zn) Tin (Sn) Manganese (Mn) Aluminum (Al) Steel Gold (Au) Other

1783 UNITS

HALF CENTS

CENTS

1787

FUGIO CENT

1792

SILVER CENTER CENT

1793

WREATH CENT

1793

CHAIN CENT

1793-1796

LIBERTY CAP LARGE CENT

1796-1807

DRAPED BUST CENT

1808-1814

CLASSIC HEAD CENT

1816-1839

MATRON HEAD CENT

1839-1857, 1868

BRAIDED HAIR CENT

1850-1851, 1853, 1884-1885

RING CENT

1856-1858

FLYING EAGLE CENT


1859-1864
88% 12%
INDIAN HEAD CENT
1864-1909
95% 5% (ZINC/TIN)
INDIAN HEAD CENT
1884-1885
90% 10%
RING CENT
1909-1942
95% 5% (ZINC/TIN)
LINCOLN CENT
1942
100% Plastic
EXPERIMENTAL COLUMBIA CENTS
1943
99% 1%
STEEL CENT
1944-1958
95% 5% (ZINC/TIN)
LINCOLN CENT
1959-1962
95% 5% (ZINC/TIN)
LINCOLN CENT
1963-1982
95% 5%
LINCOLN CENT
1974-1975
96% 4% Trace minerals
ALUMINUM CENT
1982-2008
97.25% 2.5%
LINCOLN CENT
2009
97.25% 2.5%
LINCOLN BICENTENNIAL CENT

TWO CENTS

THREE CENTS

FIVE CENTS


1792
100%
HALF-DISME
1794-1795
89% 11%
FLOWING HAIR HALF-DIME
1796-1797, 1800-1805
89% 11%
DRAPED BUST HALF-DIME
1829-1837
89% 11%
CAPPED BUST HALF-DIME
1837-1873
90% 10%
SEATED LIBERTY
1866
75% 25%
WASHINGTON NICKEL
1866-1883
75% 25%
SHIELD NICKEL
1883-1912 (1913 rare)
75% 25%
LIBERTY HEAD NICKEL
1913-1938
75% 25%
BUFFALO NICKEL
1938-Present
75% 25%
JEFFERSON NICKEL
1942-1945
56% 35% 9%
WAR NICKELS

TEN CENTS

1792

DISME

1796-1807

DRAPED BUST DIME

1809-1837

CAPPED BUST DIME

1837-1891

SEATED LIBERTY DIME

1892-1916

BARBER DIME

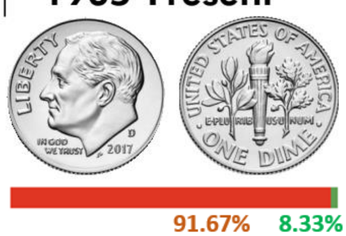
1916-1945

MERCURY DIME

1946-1964

ROOSEVELT DIME

1965-Present



ROOSEVELT DIME

TWENTY CENTS

TWENTY-FIVE CENTS

1975-1976

91.67% 8.33%*

BICENTENNIAL WASHINGTON QUARTER

1965-1998

91.67% 8.33%

WASHINGTON QUARTER

1999-2008

91.67% 8.33%

WASHINGTON STATE QUARTERS

2009

WASHINGTON TERRITORIES QUARTERS

2010-Present

AMERICA THE BEAUTIFUL QUARTERS

FIFTY CENTS

1794-1795

89% 11%

FLOWING HAIR HALF-DOLLAR

1796-1807

89% 11%

DRAPED BUST HALF-DOLLAR

1807-1836

89% 11%

CAPPED BUST HALF-DOLLAR

1836-1839

90% 10%

CAPPED BUST HALF-DOLLAR

1839-1891

90% 10%

SEATED LIBERTY HALF-DOLLAR

*Bicentennial silver clad coins have outer layers of 80% silver and 20% copper bonded to an inner core of 20.9 % silver and 79.1% copper. Their overall composition is 40% silver and 60% copper.

1892-1915

90% 10%

BARBER HALF-DOLLAR

1916-1947

90% 10%

WALKING LIBERTY HALF-DOLLAR

1948-1963

90% 10%

FRANKLIN HALF-DOLLAR

1964-1965

90% 10%

KENNEDY HALF-DOLLAR

1965-1971

60% 40%

KENNEDY HALF-DOLLAR

1975-1976

60% 40%*

KENNEDY BICENTENNIAL HALF-DOLLAR

1971-Present

91.67% 8.33%

KENNEDY HALF-DOLLAR

ONE DOLLAR

1776

100% Pewter

CONTINENTAL CURRENCY DOLLAR

1794-1795

89.2% 10.8%

FLOWING HAIR DOLLAR

1795-1804

89.2% 10.8%

DRAPED BUST DOLLAR

*Bicentennial silver clad coins have outer layers of 80% silver and 20% copper bonded to an inner core of 20.9 % silver and 79.1% copper. Their overall composition is 40% silver and 60% copper.

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AMERICAN INNOVATION DOLLAR

ONE GOLD DOLLAR

GOLD DOLLAR

TWO AND A HALF GOLD DOLLAR

CAPPED BUST QUARTER-EAGLE

CLASSIC HEAD QUARTER-EAGLE

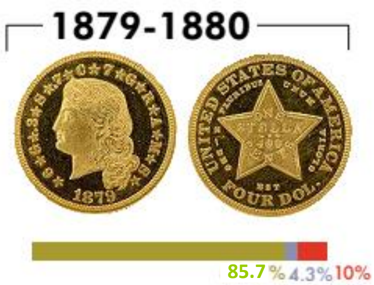
LIBERTY HEAD QUARTER-EAGLE

INDIAN HEAD QUARTER-EAGLE

THREE DOLLAR GOLD

THREE-DOLLAR PIECE

FOUR DOLLAR GOLD



STELLA

FIVE DOLLAR GOLD

TURBAN HEAD HALF-EAGLE

DRAPED BUST HALF-EAGLE

CLASSIC HEAD HALF-EAGLE

LIBERTY HEAD HALF-EAGLE

INDIAN HEAD HALF-EAGLE

TEN DOLLAR GOLD

TWENTY DOLLAR GOLD

FIFTY DOLLAR GOLD

SOURCES:
https://www.pcgs.com
https://www.usmint.gov/learn/history/coin-production
https://www.usmint.gov/wordpress/wp-content/uploads/2018/07/coin_composition_history.jpg
https://www.usmint.gov/learn/history/timeline-of-the-united-states-mint
https://www.usmint.gov/learn/history/us-circulating-coins
https://en.wikipedia.org/wiki/Numismatic_history_of_the_United_States it
Chart modified from alansfactoryoutlet.com

CHAPTER 2

Sources Causing Alloy Textures

The Coinage Act of 1792 authorized the Mint to produce copper, silver, and gold coins for circulation. The Act specified that the government must buy the copper needed to coin half cents and cents (as raw material or as blanks already the appropriate size for coining). Depositors, such as banks and individuals provided the silver and gold. The silver and gold were either in the form of foreign coins or bullion that the Mint melted down and refined to the appropriate fineness for coining.

The Annual Report of the Director of the Mint shows annually that damaged copper coins and obsolete copper coins were melted down and recycled into new coinage.

1843 Large Cent

With multiple sources obtained for early copper there are instances where different purities of copper did not mix well when made into blanks. This resulted in a texture to the surface often referred to as a woody. Pictured are a 1793 Sheldon 15 and an 1843 large cent showing the impurities within the copper stock causing the wood grain effect.

1793 Sheldon 15

With the rise of pure copper continuing to climb the US mint began to create alloys of different metals with the copper. Pattern ring cents were first struck in 1850 in various test compositions. However, it was found that the coin was difficult to eject from the presses and that it was expensive to recover the silver from the alloy. Because of this, the ring cent was not placed into mass-production and the large cent continued to be produced until 1856, when it was replaced by the Flying Eagle cent.

With the new composition of eighty-eight percent copper and twelve percent nickel the Mint was able to reduce the costs associated with the rising cost of pure copper. What wasn't considered was the continuous melting of worn and outdated currency that was melted yearly and added to the smelting process. With pure copper having a melting point of 1,983(F) and Nickel with a melting point of 2,647(F) [1] it is not uncommon to see a similar woodgrain appearance but with a different cause. Here the cause is created by an improper alloy mix where the addition of one or more alloys introduced to pure copper does not mix correctly or reach the correct melting point.

Seen here is an 1857 Flying Eagle showing the improper alloy mix of Copper and Nickel.

Changes again occurred due to rising minting costs in 1864. The changes included the removal of Nickel and introduction of a five percent Zinc/Tin ratio. This alloy mix continued through 1942 with a

one year steel cent in 1943. In 1944 the mint reverts back to the Zinc and Tin ratio of five percent. This combination of three alloys produced some of numismatics best Improper Alloy Mix combinations. Additional amounts of Zinc were added to the mix to compensate for evaporation during the smelting process and with Copper having a melting point of 1,983(F), Zinc having 787(F) (evaporating at 1,600(F)) and Tin with 449(F)[2] (evaporating at 4,118(F)) it was not uncommon to have the ratios not be exact.

In an article written by Frank H. Storer on November 9, 1859 called *On The Alloys of Copper and Zinc* he writes:

Those in which the proportion of copper was large were prepared by projecting granulated zinc by small portions into the molten copper, the crucible which contained it having been previously removed from the fire, the mixture being thoroughly stirred after each addition of zinc. This method succeeds very well when only a small amount of zinc is to be combined with the copper, perfect combination of the metals being readily obtained while the loss of zinc from volatilization, though considerable, is, if proper care be exercised, much less than would be at first sight supposed.

It is in this case necessary to bring the copper to a high degree of heat before adding the zinc; yet in spite of this precaution, and of the utmost care in adding the zinc only by small portions, which have previously been made as hot as possible, the mass contained in the crucible will often become chilled and require to be again placed in the furnace in order to be remelted. Since the portion of zinc last added remains uncombined with the copper, and exposed at the surface of the mass, a great deal of it is lost during this operation.[1]

[1] Publication date 1861-01-01, Memoirs of the American Academy of Arts and Sciences jstor_mameracadartssci; jstor_ejc; additional_collections; journals, On the Alloys of Copper and Zinc: Storer, Frank H. : Internet Archive, pg28

It is, however, possible, that at times, when the temperature of the reverberatory, in which the alloy is heated before passing to the rollers, is not properly regulated, zinc may be burned off from the exterior portions of the sheet, and that the alloy richer in copper which would thus be formed may subsequently be pressed into the body of the sheet during the operation of rolling.[2]

Evaporation of Zinc is most likely one of the causes of the woodie effect.

The Improper Alloy Mix is found throughout the production of minor coinage, from civil war tokens to the Indian Head Cent series and then Lincoln Wheat Cent Series, tapering off in the mid 1950's and completely disappearing in the Lincoln Memorial Cent series.

Improper Alloy Mix coins were not limited to just minor copper coinage but also appear in other denominations, as seen in this 1910 V Nickel, until the minting of clad coins begin.

[2] Publication date 1861-01-01, Memoirs of the American Academy of Arts and Sciences jstor_mameracadartssci; jstor_ejc; additional_collections; journals, On the Alloys of Copper and Zinc: Storer, Frank H.: Internet Archive, pg38

Chapter 3

The Woodgrain Effect

The woodgrain or woody effect can be broken down into four different categories:

- Impurities from a pure ore source
- The addition of one or more elements to a base metal or Improper Alloy mix
- The improper coating of a base metal
- The embedding of foreign metal during the production process.

All four of these categories can produce a woodgrain effect from a very fine striation appearance to a tiger stripe appearance on one or both sides of the coin. The more extreme patterns are more collectible.

Woodgrain coins are not limited to one country either. They can be found anywhere in the world and can be a challenge to find. This 1959 Half Penny from Great Britain is a great example of an Improper Alloy mix.

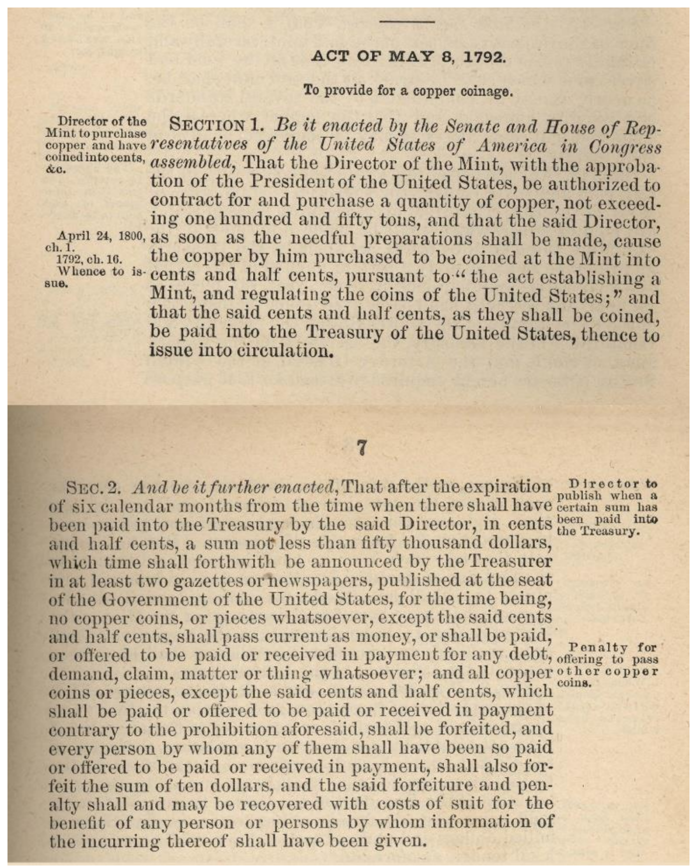
In the following chapters we will take a look at each of the four categories in more detail, exploring the cause and effect of how each technique can produce eye appealing and highly sought after specimens.

Chapter 4

Metal Impurities in Early Coppers

The Act of May 8, 1792 – To provide for a copper coinage

SECTION 1. *Be it enacted by the Senate and House of Representatives of the United States of America in Congress Assembled*, That the Director of the Mint, with the approbation of the President of the United States, be authorized to contract for and purchase a quantity of copper, not exceeding one hundred and fifty tons, and that the said Director, as soon as the needful preparations shall be made, cause the copper by him purchased to be coined at the Mint into cents and half cents, pursuant to “the act establishing a Mint, and regulating the coins of the United States;” and that the said cents and half cents, as they shall be coined, be paid into the Treasury of the United States, thence to issue into circulation.



ACT OF MAY 8, 1792.

To provide for a copper coinage.

Director of the Mint to purchase copper and have coined into cents, &c.

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April 24, 1800, ch. 1.
1792, ch. 16.
Whence to issue.

7

SEC. 2. *And be it further enacted*, That after the expiration of six calendar months from the time when there shall have been paid into the Treasury by the said Director, in cents and half cents, a sum not less than fifty thousand dollars, which time shall forthwith be announced by the Treasurer in at least two gazettes or newspapers, published at the seat of the Government of the United States, for the time being, no copper coins, or pieces whatsoever, except the said cents and half cents, shall pass current as money, or shall be paid, or offered to be paid or received in payment for any debt, demand, claim, matter or thing whatsoever; and all copper coins or pieces, except the said cents and half cents, which shall be paid or offered to be paid or received in payment contrary to the prohibition aforesaid, shall be forfeited, and every person by whom any of them shall have been so paid or offered to be paid or received in payment, shall also forfeit the sum of ten dollars, and the said forfeiture and penalty shall and may be recovered with costs of suit for the benefit of any person or persons by whom information of the incurring thereof shall have been given.

Director to publish when a certain sum has been paid into the Treasury.

Penalty for offering to pass other copper coins.

Image courtesy of usmint.gov

Mint Director David Rittenhouse had planned to begin the coinage of copper cents in the opening year of the new mint 1792. Rittenhouse was unable to do so because of problems obtaining a steady supply of copper. He (Rittenhouse) delayed starting coinage until early in 1793

when a regular quantity of copper fit for coinage could be obtained. Rittenhouse attacked the difficulty head-on by arranging for merchants to import sheet copper from Britain. This copper began to arrive late in 1792 and was on hand for the start of coinage in February 1793.

This copper source was used until about 1800. The isotope composition of early coins spanning the period 1800 to 1843 reflects the copper from Cornish ores from England, while coins after 1850 reflect the Keweenaw Peninsula, Michigan ores, a finding consistent with historical records.[3] A number of copper mines also contained a notable amount of silver, both in native form and naturally alloyed with the copper. *Halfbreed* is the term for an ore sample that contains the pure copper and pure silver in the same piece of rock; it is only found in the native copper deposits of the Upper Peninsula of Michigan.[4]

Occasionally coins minted during this time period will exhibit woodgrain appearances from trace elements not separating correctly.

Pure copper was used at the US Mint until the composition changed to eighty-eight percent copper and twelve percent nickel in 1856.

[3] Mathur, R (2009). "The history of the United States cent revealed through copper isotope fractionation". *Journal of Archaeological Science*. **36** (2): 430–433. doi:10.1016/j.jas.2008.09.029

[4] "Halfbreed: Halfbreed mineral information and data". *Mindat.org*. Hudson Institute of Mineralogy.

Chapter 5

The Improper Alloy

Due to the increasing cost of pure copper a change was made in 1856 to add twelve percent zinc to the copper. This was short lived as an alternative was still needed and in the 1864 production year the mixture was changed to ninety-five percent copper and a five percent mixture of zinc and tin. This mixture continues until 1962 when tin is removed and only copper and zinc remain.

This era produces some of the boldest alloy mixes in numismatic collecting. As Joe Cronin describes it in a CoinTalk thread in 2020: *It could be that impurities/contaminants corrupted the mixture (dust, dirt, etc.), or that the percentages of the ingredients is off significantly, or it could be that some of the metallic particles didn't fully melt completely, or a combination of these. In any of these cases, improper alloy mixes can sometimes result in various color patterns that are abnormal. They can appear as stripes, blotches, irregular patterns, shades, and can compromise the integrity of the metal itself resulting in laminations, cracks, splitting, and other planchet defects.* [5]

A normal alloy mix copper was scanned using a SEM/EDX scan performed at Michigan State University's Center for Advanced Microscopy in East Lansing, Michigan.

A 1921 S was chosen for this scan [Image 1, pg. 38], and two field areas were tested [Image 2, pg. 38]. The darker was in line with the base results [Image 3 and 4 pg. 39] and the lighter areas [Image 5 and 6 pg. 40] once again had elevated tin readings although not as high as tin bronze but enough to resist tarnishing as much as a normal copper alloy.

[5]https://www.cointalk.com/threads/i-think-i-have-a-improper-alloy-mix-1980p-penny-error.363215/page-2

Image 1

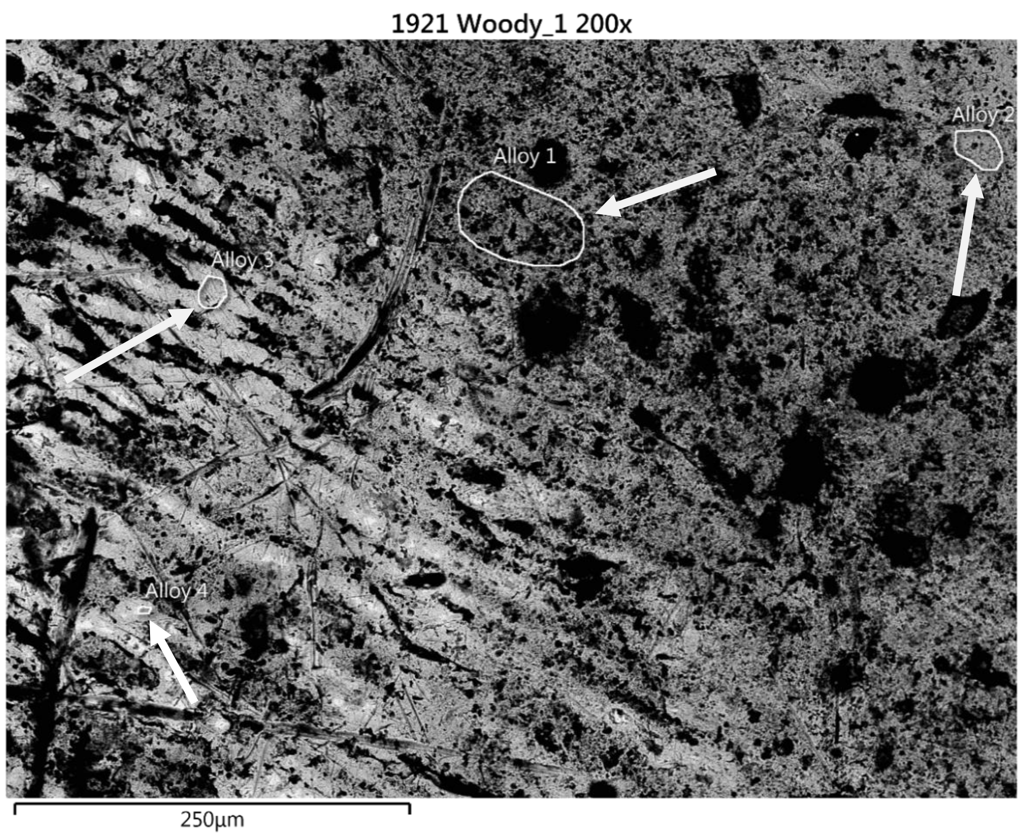


Image 2

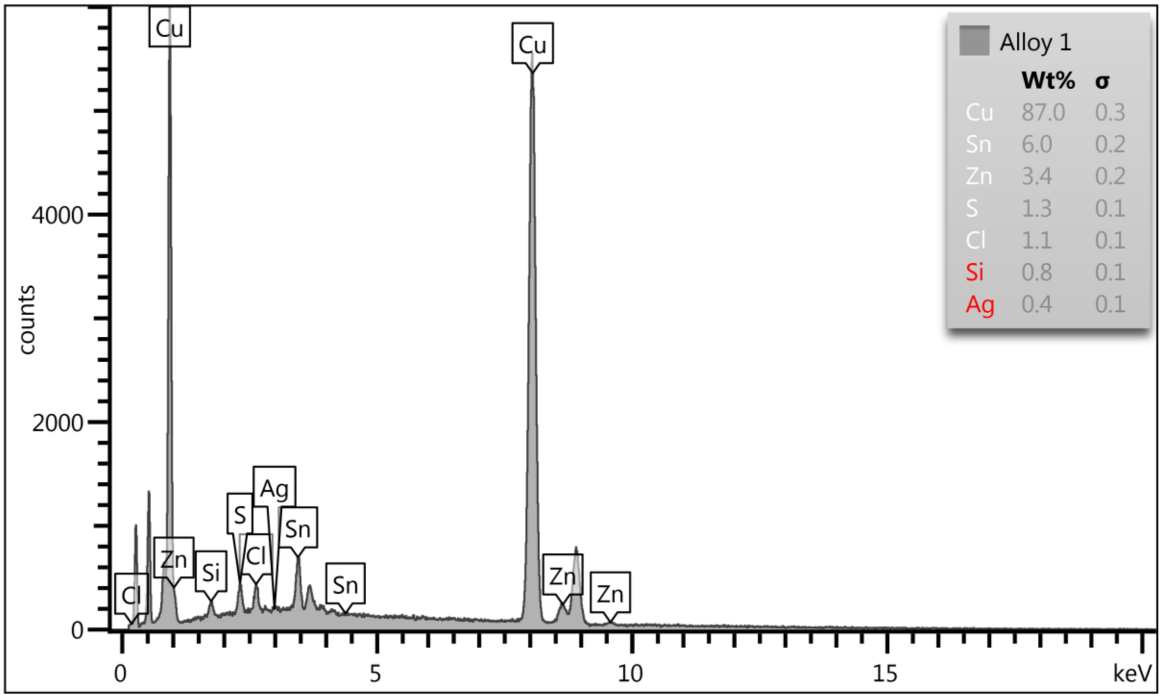


Image 3

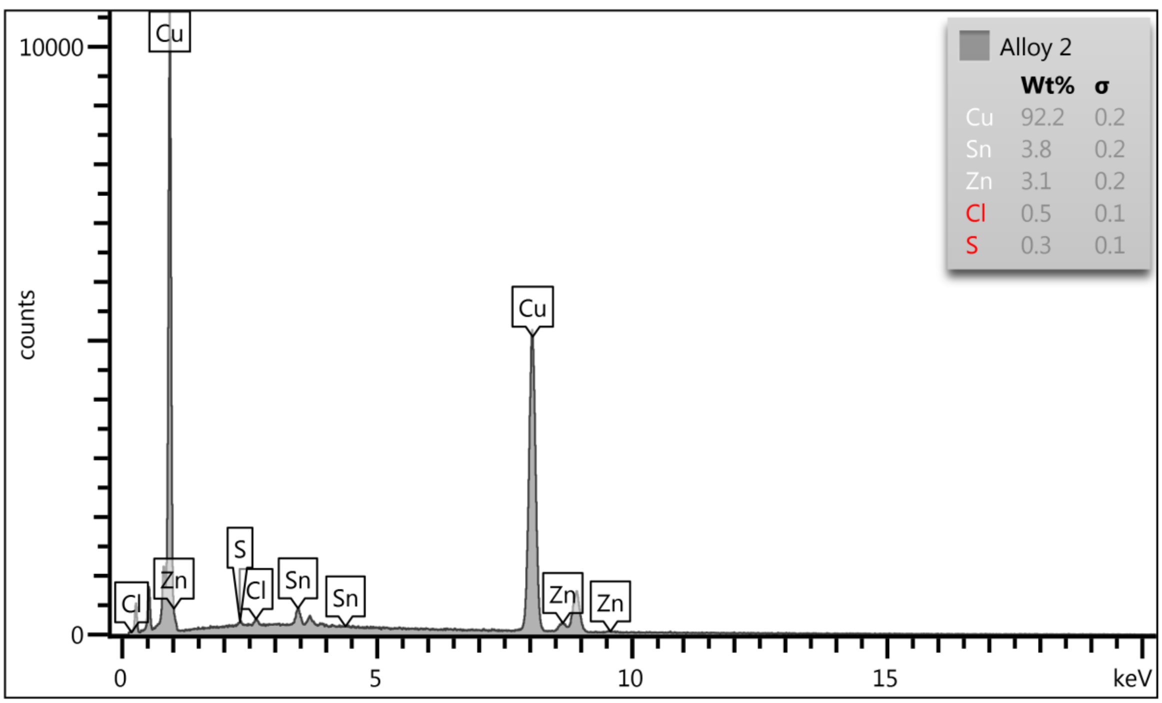


Image 4

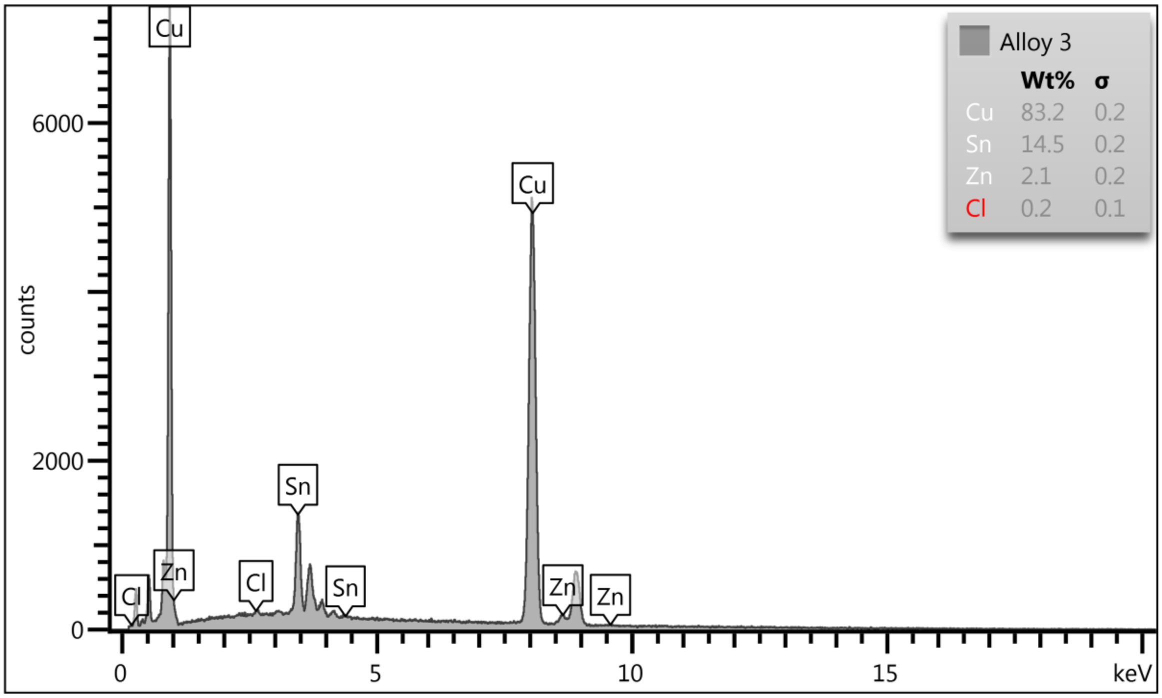


Image 5

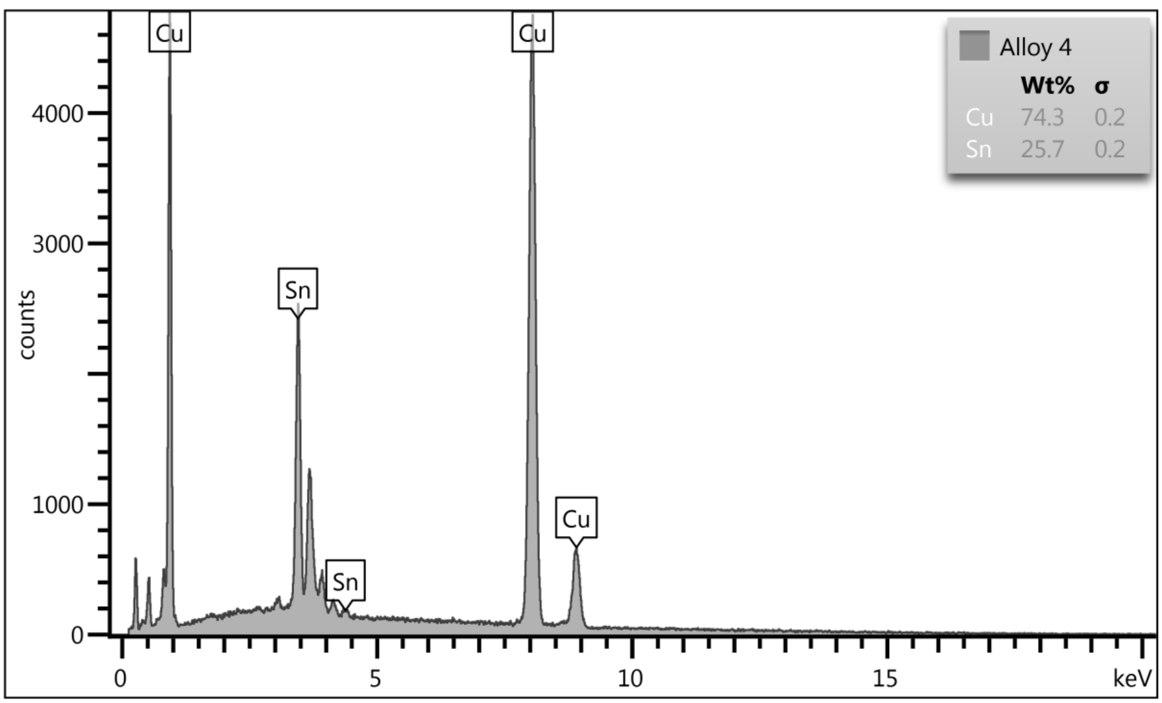
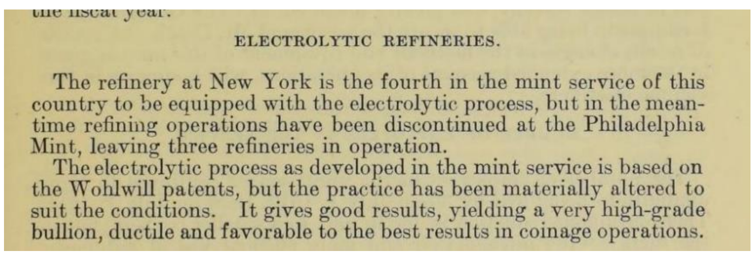


Image 6

In 1910 and 1911 an additional phenomenon occurred in the typical alloy mix error. This has the appearance of hardened flakes throughout the planchet and is referred to as Irregular Alloy Flakes.

The Annual Report of the Mint Director for fiscal years 1911 and 1912 indicate that the Philadelphia Mint refinery was shut down for improvements and that ingots and planchets were purchased from an outside source. As a result, this is the only time that these flakes appear in copper alloy one cent planchets and the only time the mint purchases from outside their own refinery during that era.

The following images are from the 1912 Annual Report of the Mint Director. (Let it be noted that the mint's fiscal year is from June 30 to June 30.) The planchets purchased for 1911 most likely were used at the end of the 1910 mintage and the beginning of the 1911 mintage.

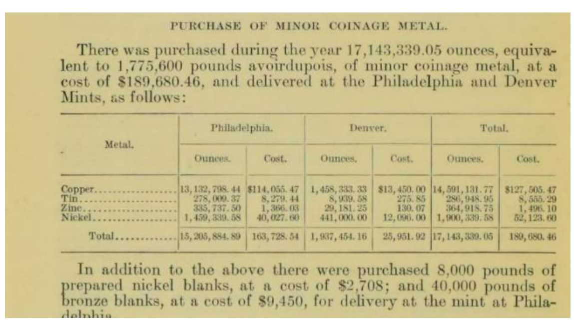


the fiscal year.

ELECTROLYTIC REFINERIES.

The refinery at New York is the fourth in the mint service of this country to be equipped with the electrolytic process, but in the meantime refining operations have been discontinued at the Philadelphia Mint, leaving three refineries in operation.

The electrolytic process as developed in the mint service is based on the Wohlwill patents, but the practice has been materially altered to suit the conditions. It gives good results, yielding a very high-grade bullion, ductile and favorable to the best results in coinage operations.



PURCHASE OF MINOR COINAGE METAL.

There was purchased during the year 17,143,339.05 ounces, equivalent to 1,775,600 pounds avoirdupois, of minor coinage metal, at a cost of $189,680.46, and delivered at the Philadelphia and Denver Mints, as follows:

Metal.	Philadelphia.		Denver.		Total.	
	Ounces.	Cost.	Ounces.	Cost.	Ounces.	Cost.
Copper	13,132,798.44	$114,055.47	1,458,333.33	$13,450.00	14,591,131.77	$127,505.47
Tin	278,009.37	8,279.44	8,939.58	275.85	286,948.95	8,555.29
Zinc	335,737.50	1,366.03	29,181.25	130.07	364,918.75	1,496.10
Nickel	1,459,339.58	40,027.60	441,000.00	12,096.00	1,900,339.58	52,123.60
Total	15,205,884.89	163,728.54	1,937,454.16	25,951.92	17,143,339.05	189,680.46

In addition to the above there were purchased 8,000 pounds of prepared nickel blanks, at a cost of $2,708; and 40,000 pounds of bronze blanks, at a cost of $9,450, for delivery at the mint at Philadelphia.

Sample 1911 A

A study analysis on flakes appearing on and within the Philadelphia Mint planchets struck during 1910 and 1911 has shown higher than normal ratios of zinc and tin compared to their normal alloy mixture of 95% copper and 5% zinc and tin. Within the flakes there were pockets of 60% copper and 35% tin found as well. The tin bronze alloy strengthens the flakes in such a way that the flake becomes less ductile and retains its appearance. Under a 10x scope a separation, like a lamination, can be seen occurring between the flake and the surrounding copper planchet, giving it an appearance that the flake could be removed. The higher-than-normal tin makes the flake less resistant to tarnishing.

Four samples were used for this study, one planchet from 1910 and three planchets from 1911.

In sample 1911 A, three areas were targeted [Image 7]. A base scan of the planchet was performed. The scan labeled base [Image 8, pg.43] resulted in a normal planchet ratio of 95% copper and 5% zinc and tin. The second area scanned labeled FLAKE [Image 9, pg.44] resulted in 86% copper and 11% tin. The third area named SPECK [Image 10, pg.44] resulted in 64% copper and 36% tin.

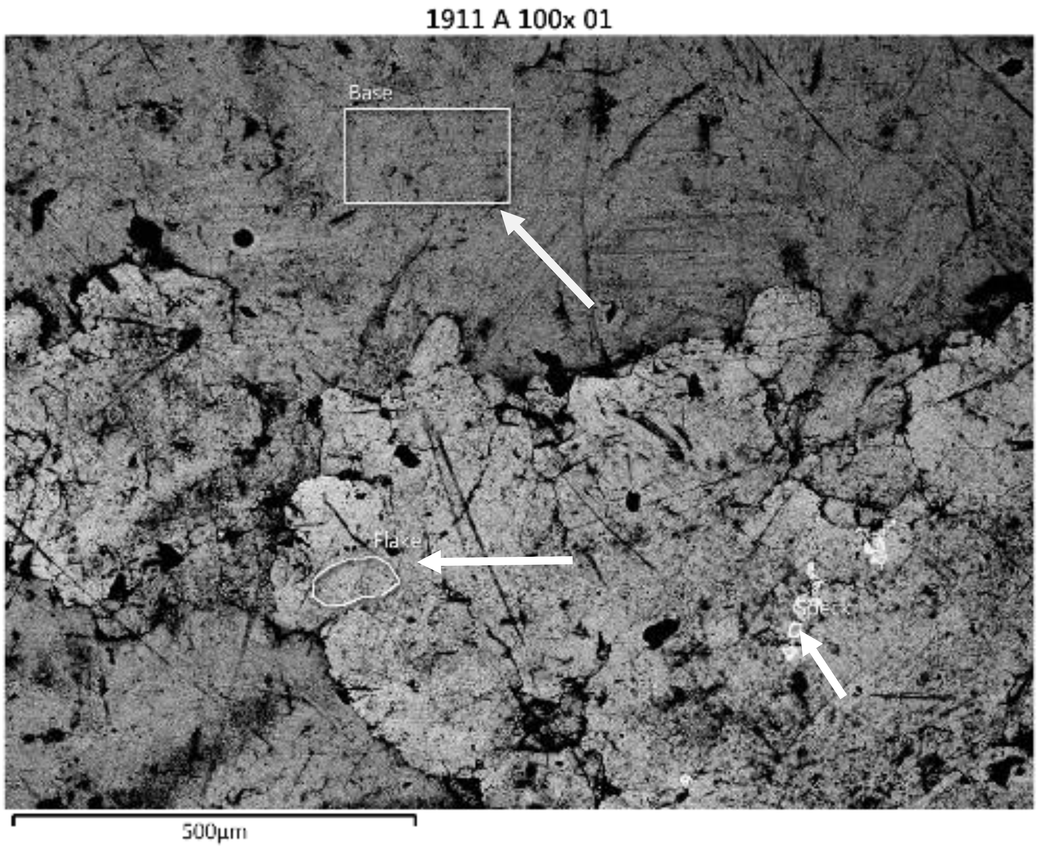


Image 7

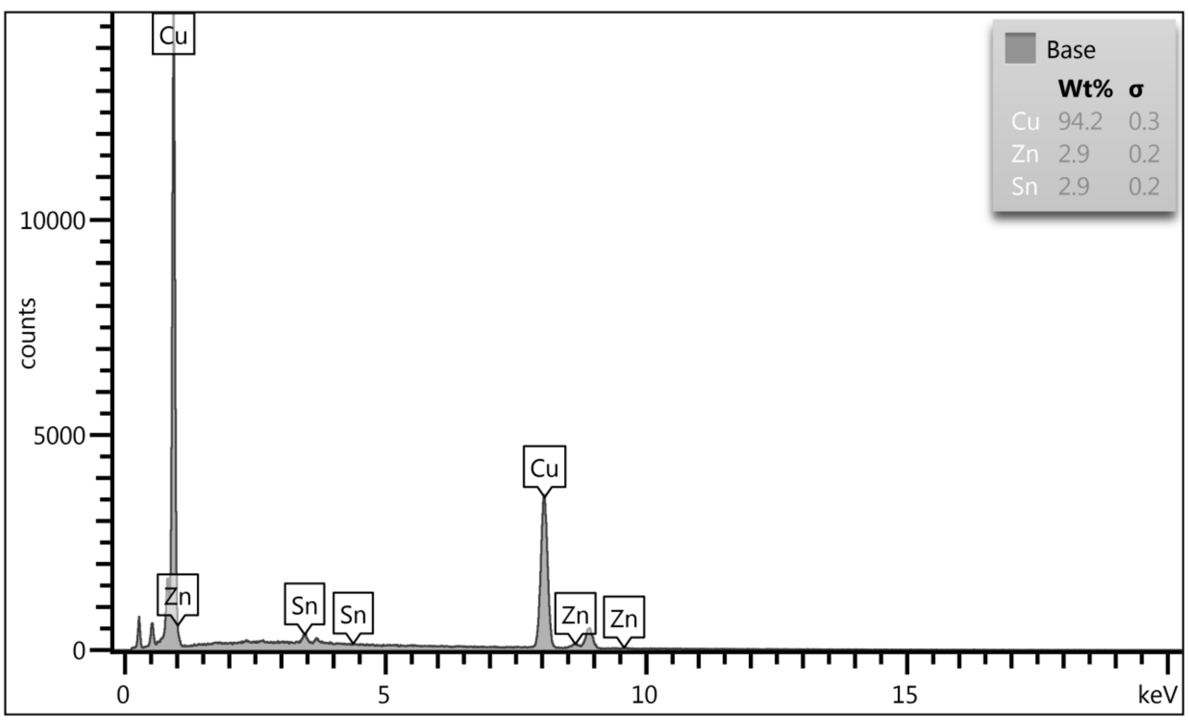


Image 8

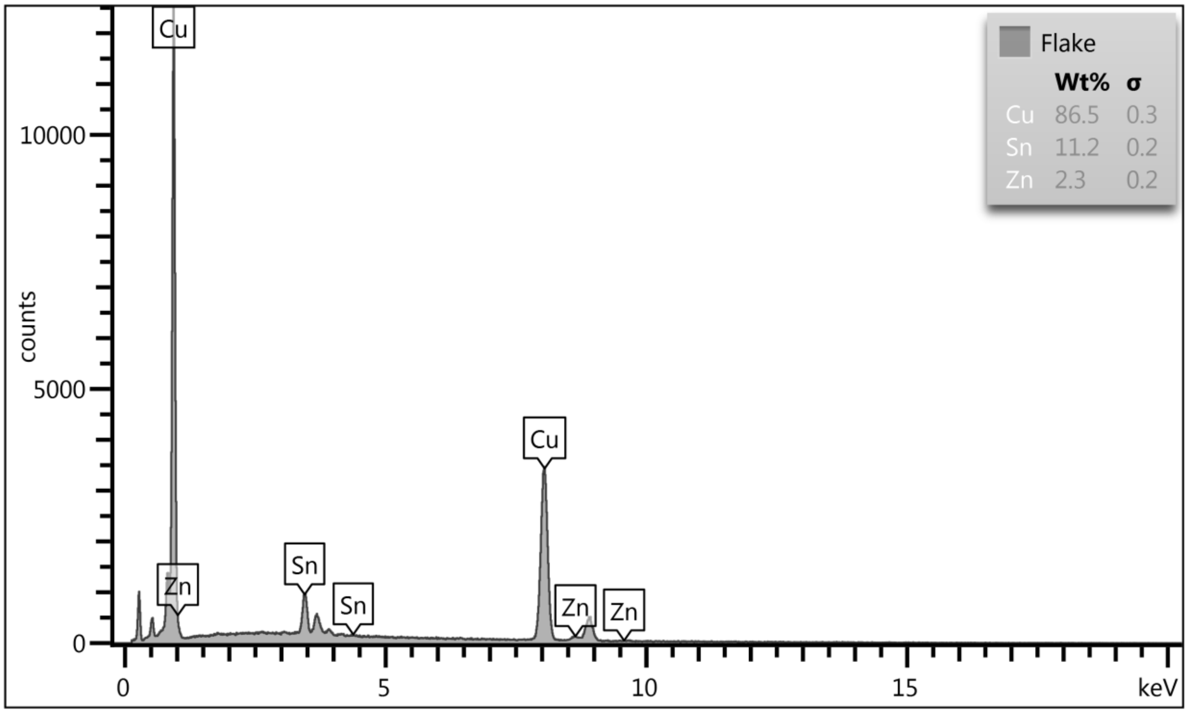


Image 9

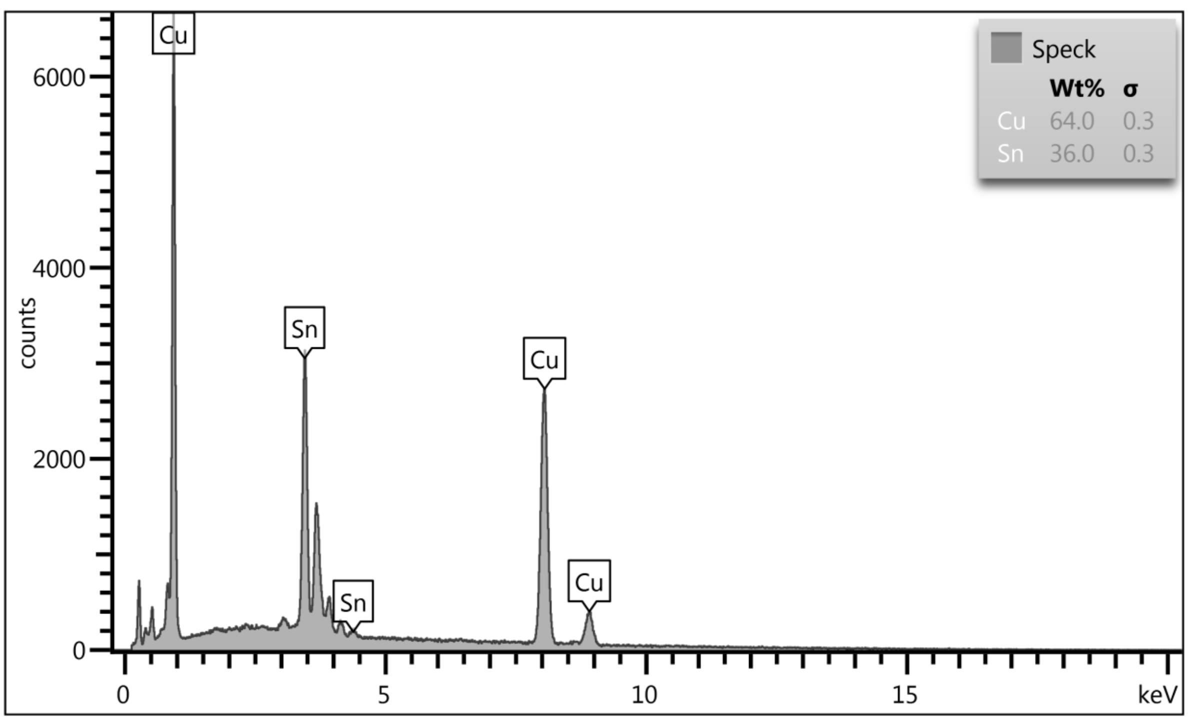
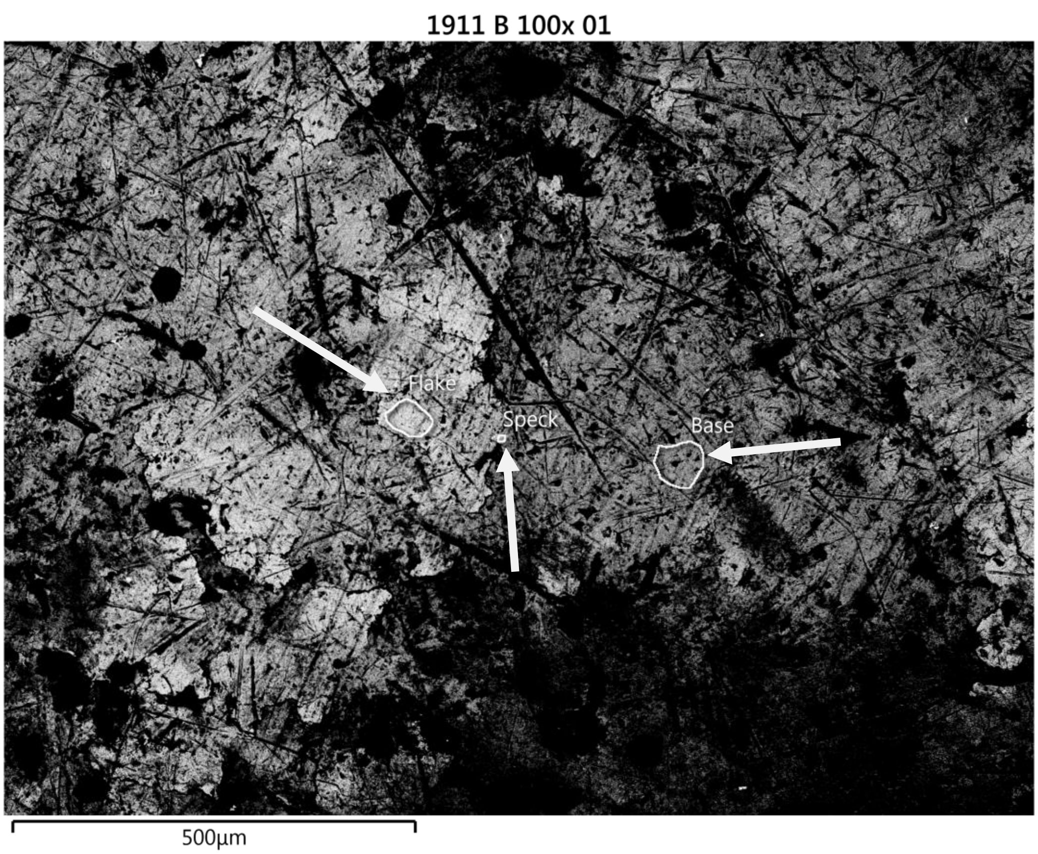


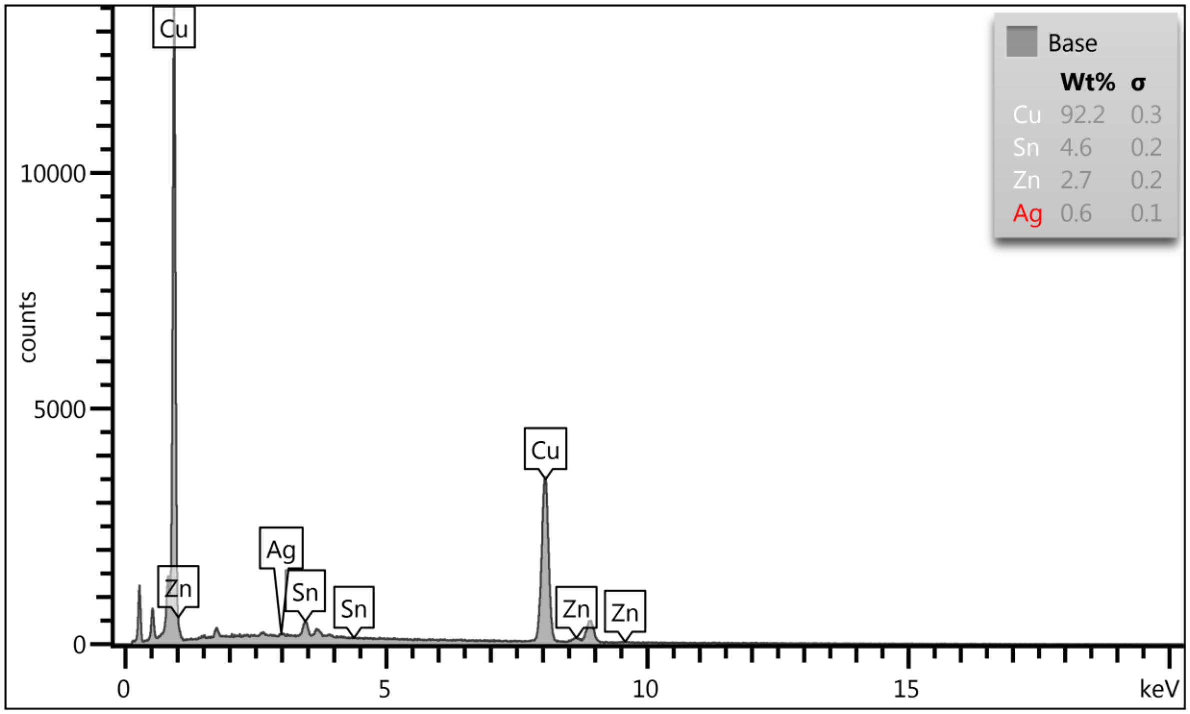
Image 10

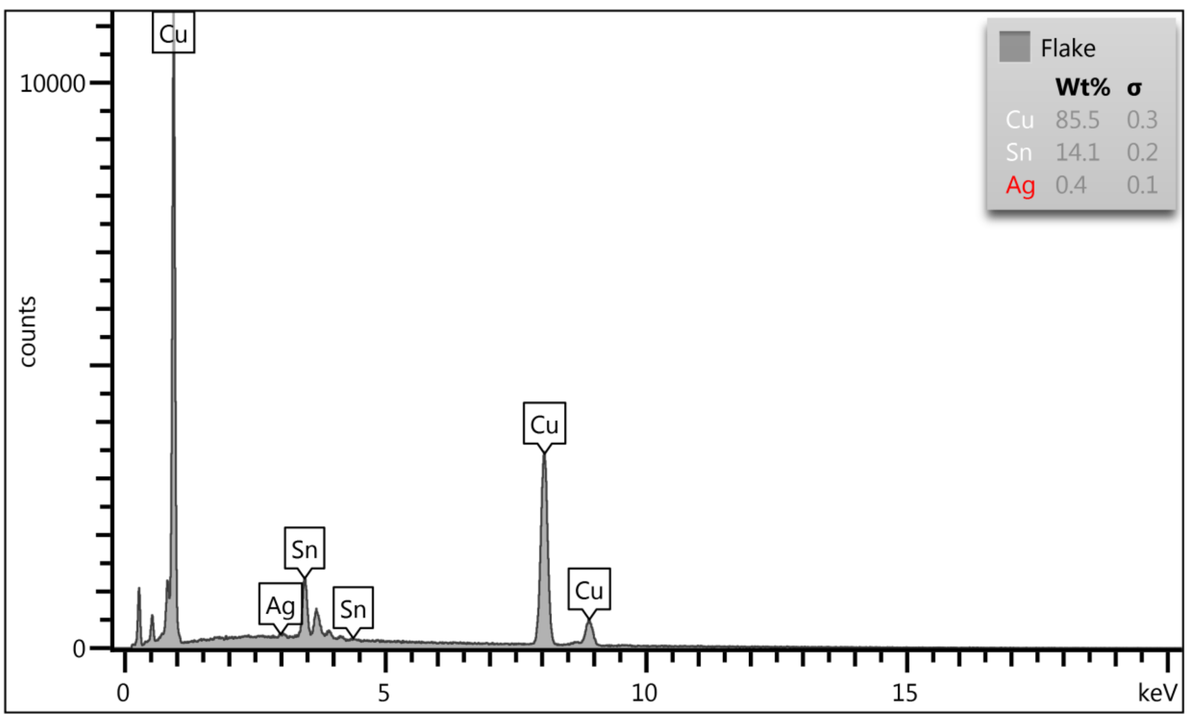
The SEM/EDX scan of Sample 1911 B revealed trace amounts of silver in both the planchet and the flakes. This most likely is due to poor refinery techniques in the copper ore refining process.

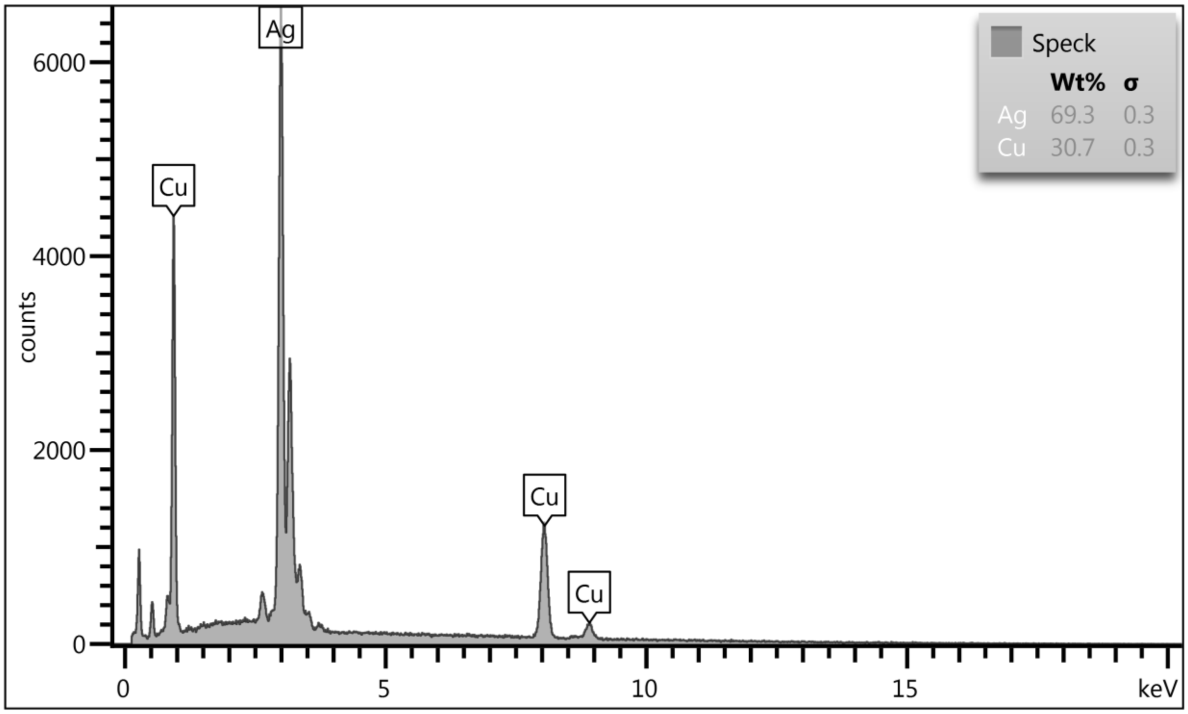
Multiple readings were performed in various areas and verified the same results as sample 1911 A.

Sample 1911 B




Base
Wt% σ
Cu 92.2 0.3
Sn 4.6 0.2
Zn 2.7 0.2
Ag 0.6 0.1
Cu
Zn
Ag
Sn
Sn
Cu
Zn
Zn
counts
10000
5000
0
0
5
10
15
keV

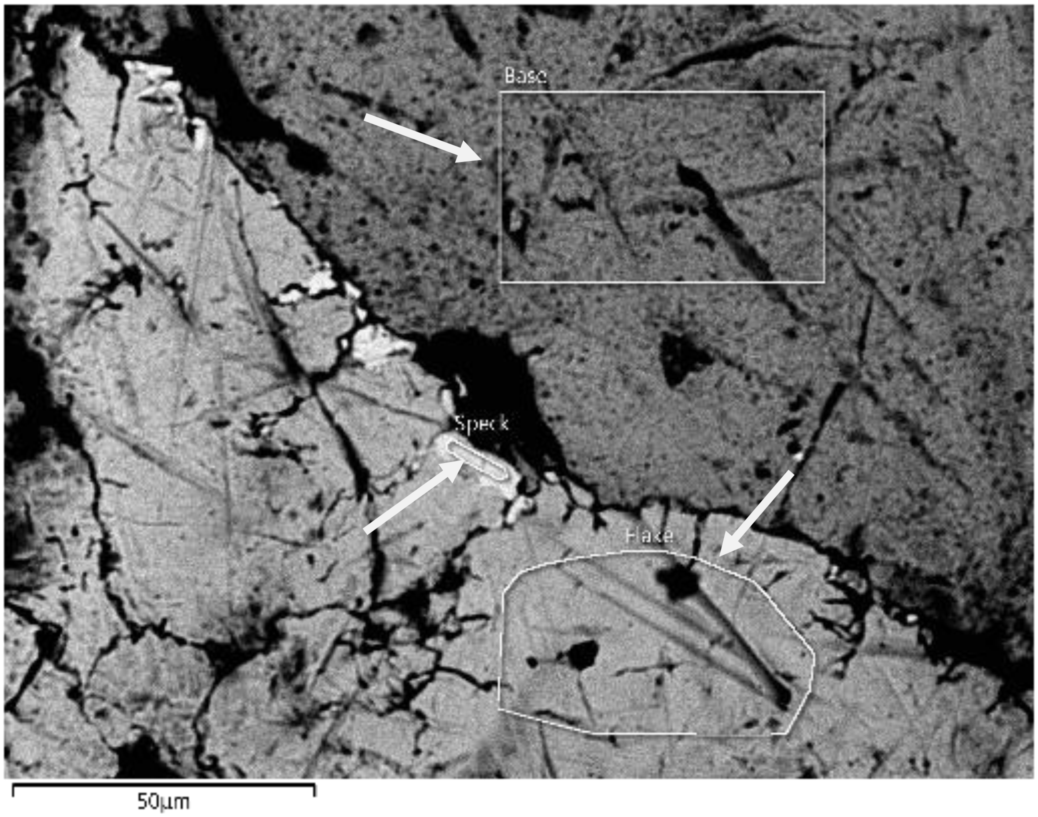

Flake
Wt% σ
Cu 85.5 0.3
Sn 14.1 0.2
Ag 0.4 0.1
Cu
Sn
Ag
Sn
Cu
Cu
counts
10000
0
0
5
10
15
keV

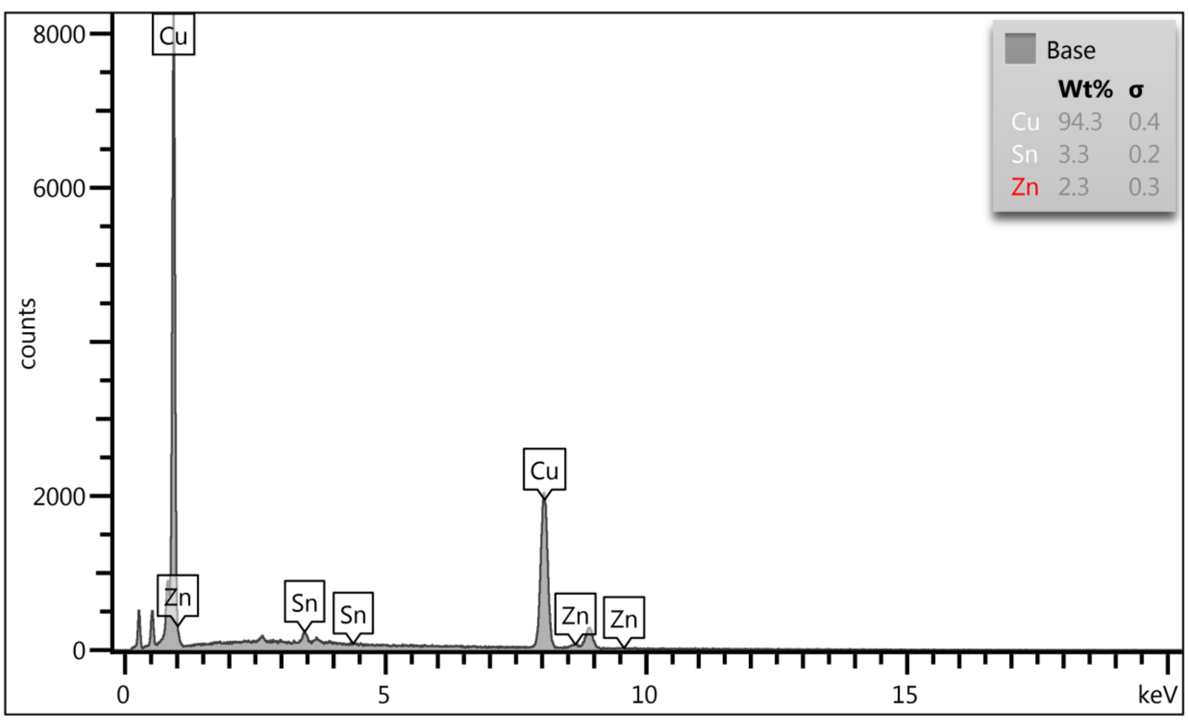


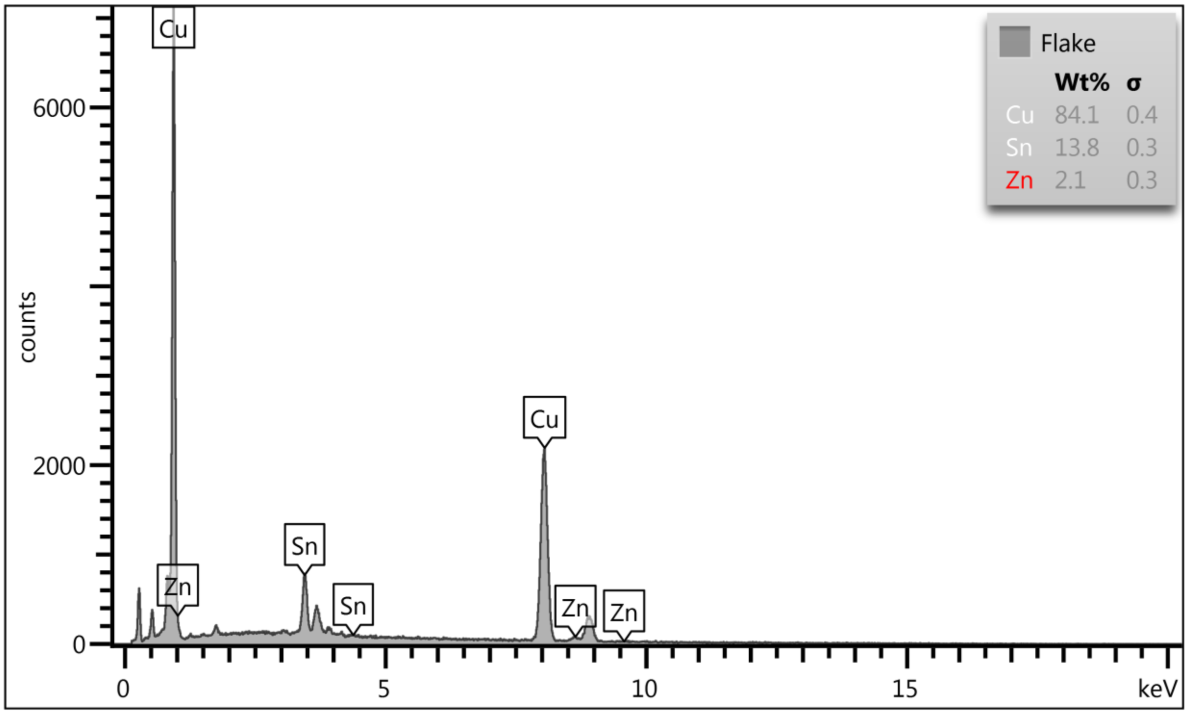
Sample 1911 C

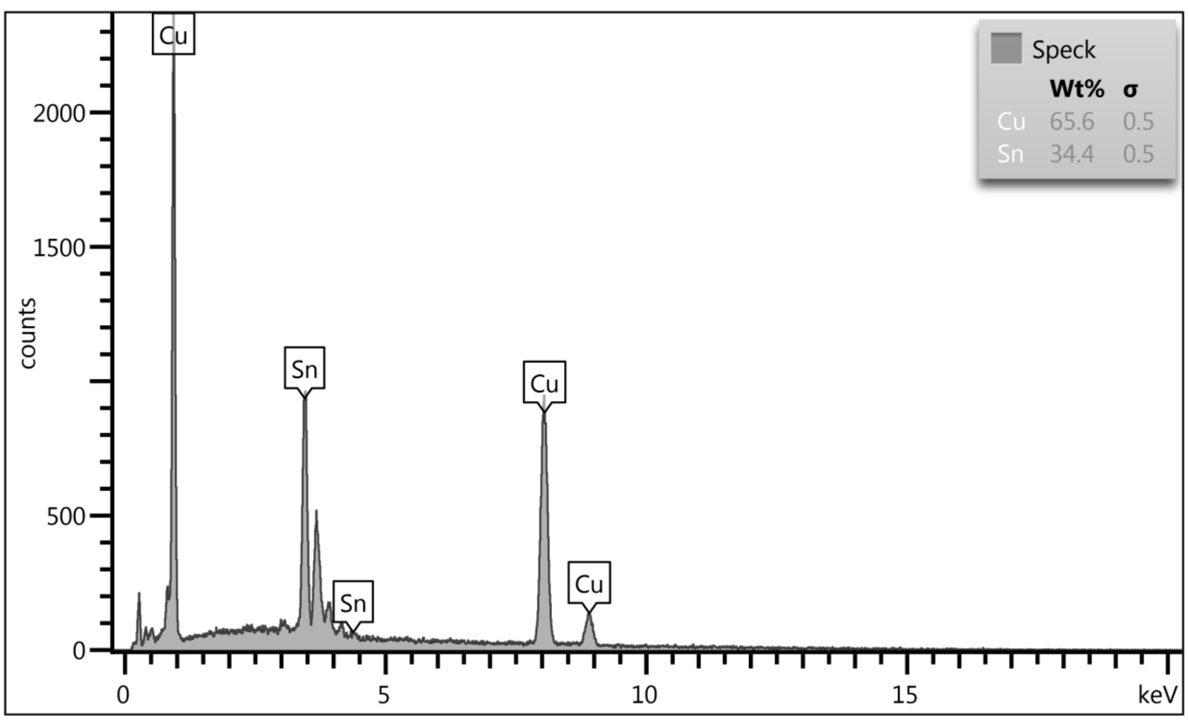
In sample 1911 C scans revealed the same as sample A and B regarding the higher tin ratio.

1911 C 750x 01





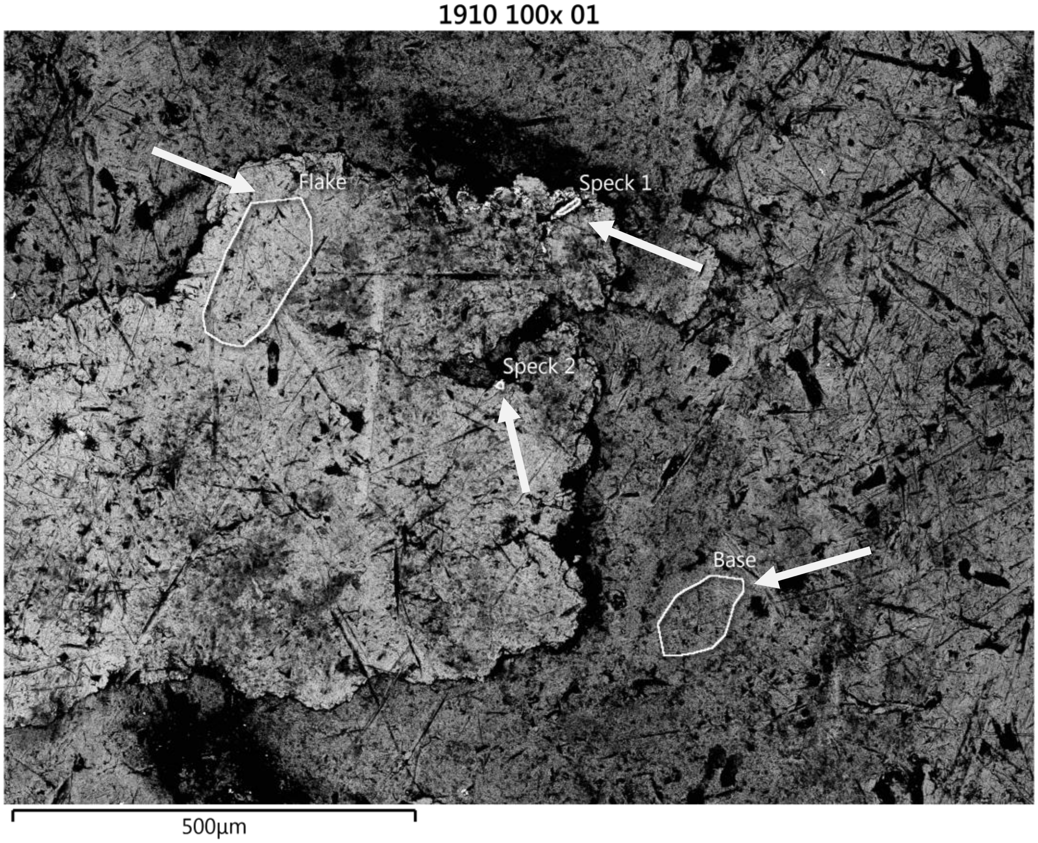

Flake
Wt% σ
Cu 84.1 0.4
Sn 13.8 0.3
Zn 2.1 0.3
counts
6000
2000
0
Cu
Zn
Sn
Sn
Cu
Zn
Zn
0
5
10
15
keV

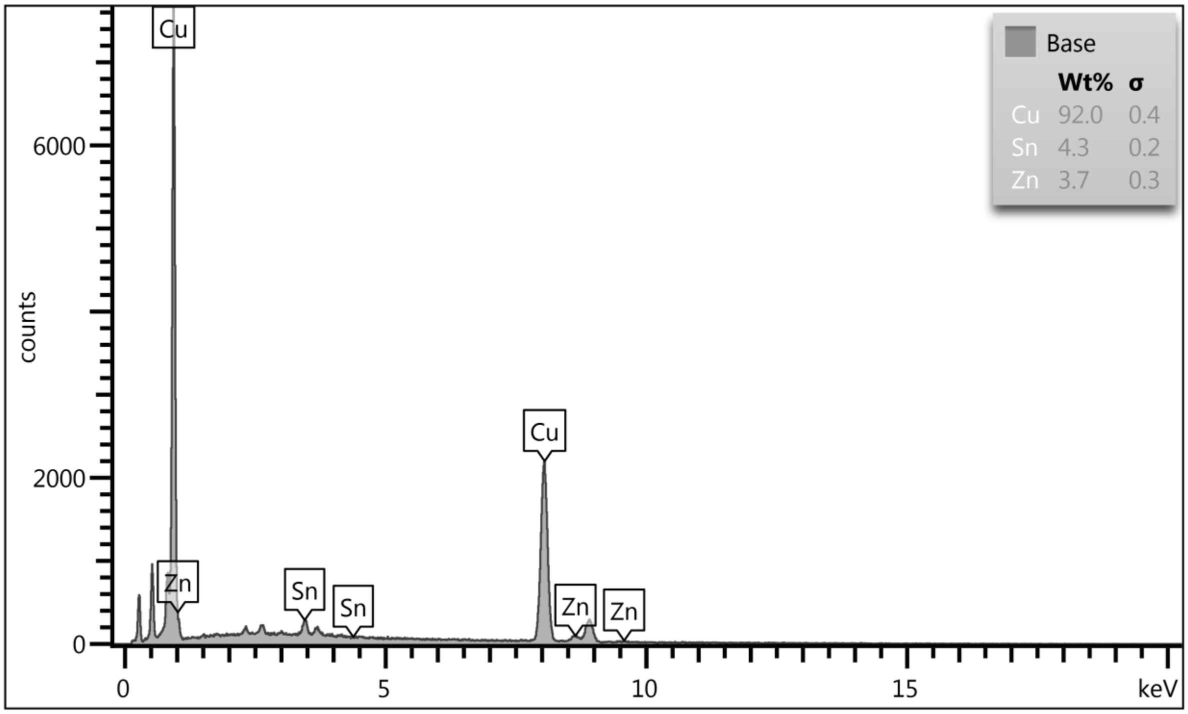

Speck
Wt% σ
Cu 65.6 0.5
Sn 34.4 0.5
counts
2000
1500
500
0
Cu
Sn
Cu
Sn
Cu
0
5
10
15
keV

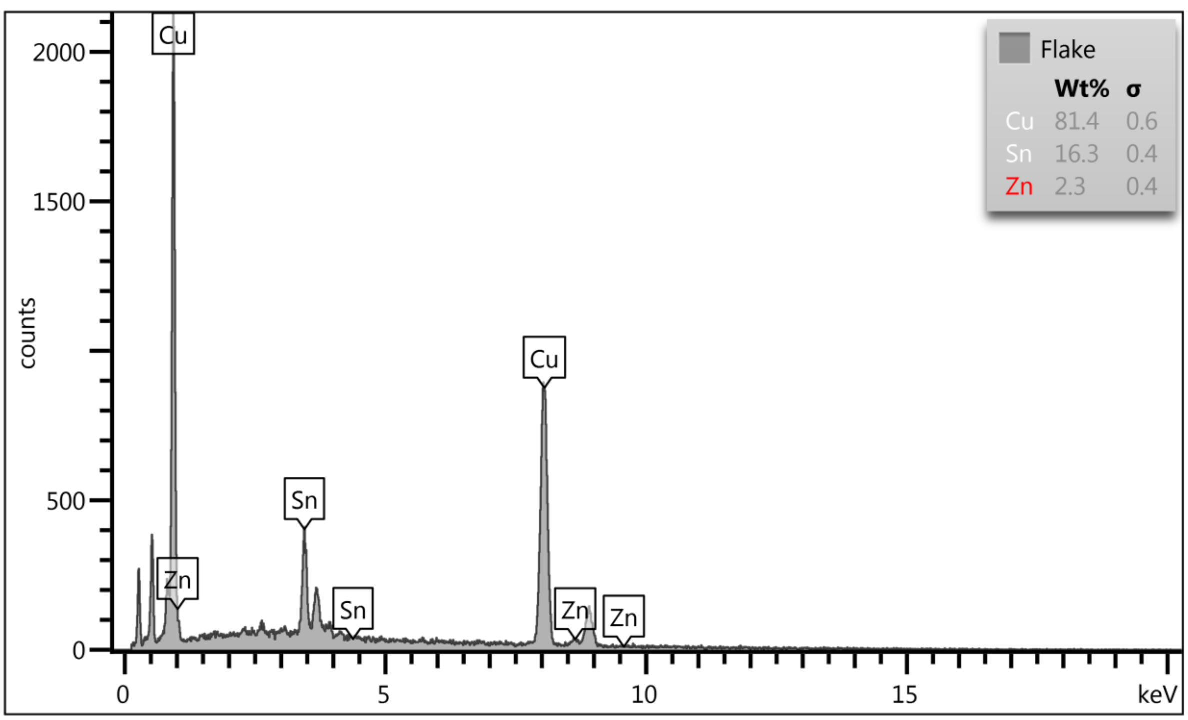
In sample 1910 scans revealed the exact same findings as the three 1911 samples.

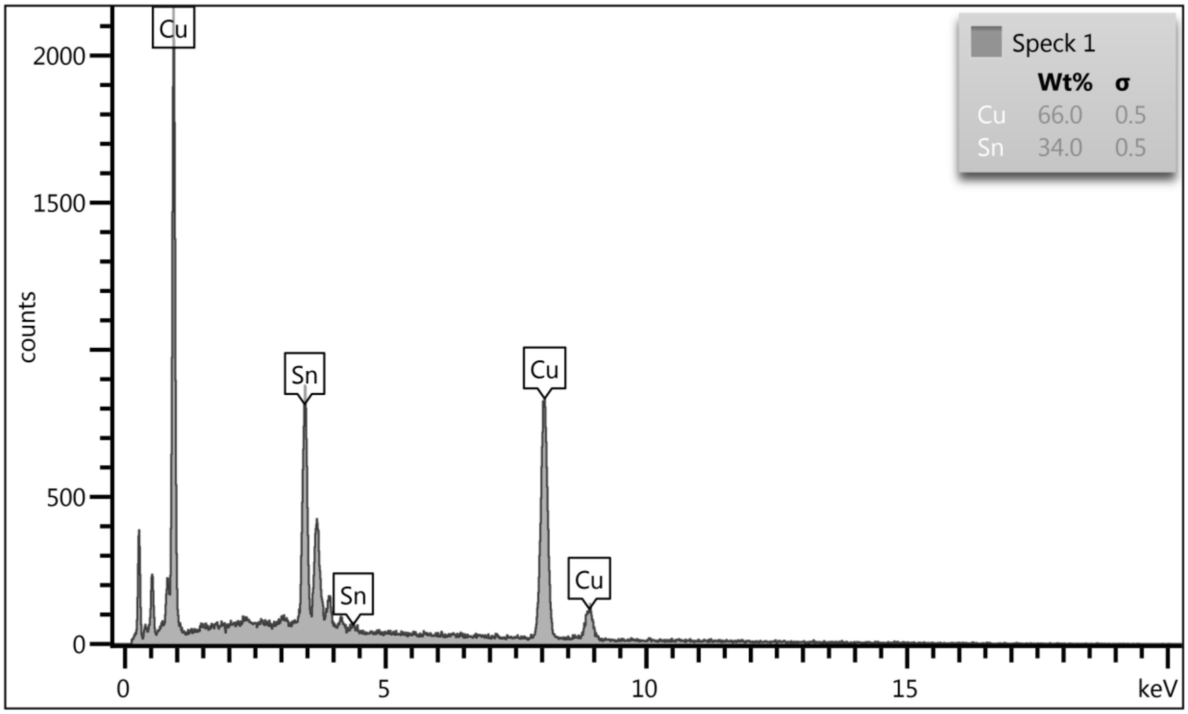
Sample 1910

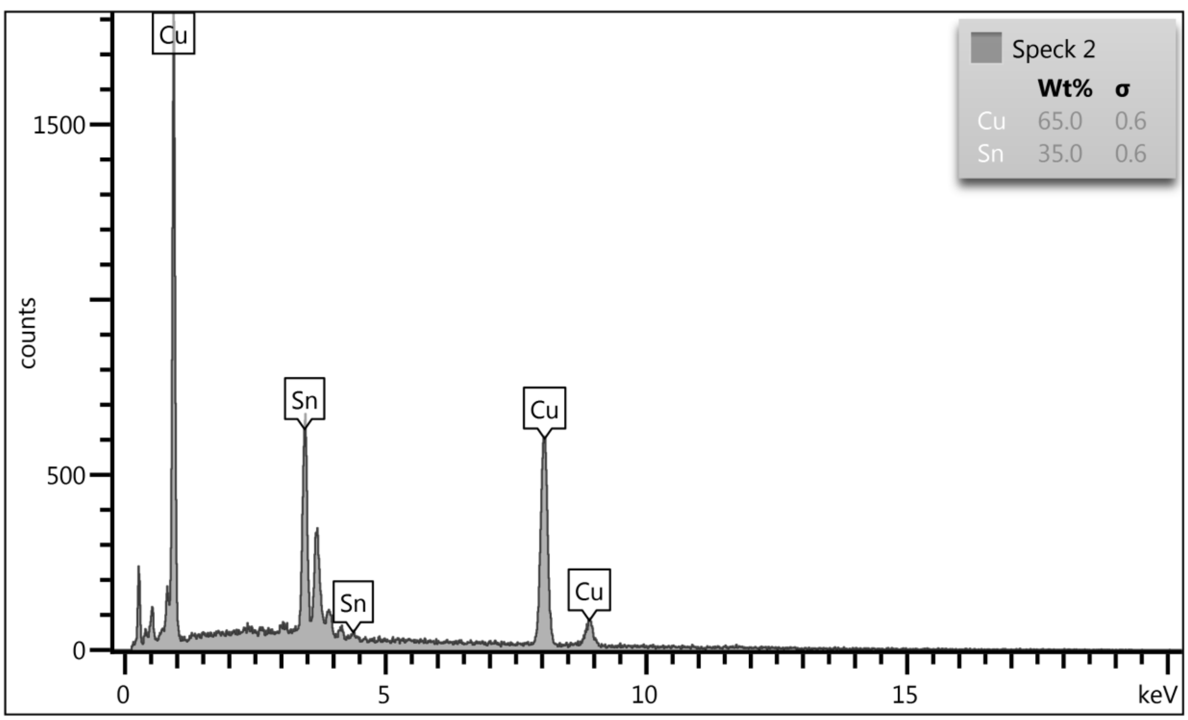
1910 100x 01




Base
Wt% σ
Cu 92.0 0.4
Sn 4.3 0.2
Zn 3.7 0.3
Cu
Cu
Zn
Sn
Sn
Zn
Zn
counts
6000
2000
0
0
5
10
15
keV


Flake
Wt% σ
Cu 81.4 0.6
Sn 16.3 0.4
Zn 2.3 0.4
Cu
Cu
Sn
Zn
Sn
Zn
Zn
counts
2000
1500
500
0
0
5
10
15
keV


Speck 1
Wt% σ
Cu 66.0 0.5
Sn 34.0 0.5
counts
2000
1500
500
0
0
5
10
15
keV
Cu
Sn
Cu
Sn
Cu


Speck 2
Wt% σ
Cu 65.0 0.6
Sn 35.0 0.6
counts
1500
500
0
0
5
10
15
keV
Cu
Sn
Cu
Sn
Cu

As improvements were made to the Philadelphia Mint refinery the following year, we no longer see this anomaly occur making this phenomenon unique to the 1910 and 1911 mintage years.

The SEM/EDX scans were performed by Amy Albin with the Michigan State University's Center for Advanced Microscopy Lab in East Lansing, Michigan. Scans at 100x and 750x were used in compiling these results. A JOEL 6610LV electron microscope was used for imaging and analysis. The EDX was done using an Oxford Instruments Aztec system software version 3.1 using a 20mm2 silicon drift detector (JOEL 6610LV SEM) and an ultra-thin window.

Chapter 6

The Improper Coating of a Base Metal

Uneven coating of base metals can also create a woodgrain effect.

This 1943 owned by Blaine Neupert shows a perfect example of not enough zinc coating being applied over the steel.

This is in stark contrast to dirty feed rollers that leave a uniform pattern on the surface of the coin making it appear similar to a woodie but has a different cause and effect, as seen on this 1978 D Ike and 1980 D Lincoln (1980 D images courtesy of Joe Cronin). Both sides are oriented in the same direction and have the same appearance.

Chapter 7

Metal Inclusions in Coins

An anomaly was discovered on the obverse side of a 1912s Lincoln wheat cent and posted April 13, 2019 by Joe Cronin on the discussion boards of Cointalk.com. The coin shows what appears to be chunks of brass colored metal embedded into the surface. This led to speculations ranging from the alloys used to make the copper blanks not mixing correctly to metal falling onto the surface, possibly gold, and being rolled in.

1912s posted by Joe Cronin on Coin Talk 2019

On November 25, 2022, Blaine Neupert on his Facebook group Lincoln Cent Coins. Rolls & Singles. Buy, Sell, Ask, Learn! posted a 1912S with similar gold-colored streaks also on the obverse. This led to the searching of other samples by me over the next few months. A sample was acquired from 1910, 1911, 1913S, 1914 and 1916S, all with chunk like metal pieces embedded onto the surface. Other anomalies like this 1910 cent were analyzed at Michigan State University’s Center for Advanced Microscopy in East Lansing, Michigan utilizing a SEM/EDX scan. This anomaly is found from 1910 to 1919 at all three mints.

The area chosen for the scan is marked by a box in the image to the left,

and within that box two areas were targeted. The area labeled BASE [Image 1] was used for a control sample and showed normal tarnishing of a Lincoln cent. It shows a normal mixture of copper, tin, and zinc. The second sample is marked STRIPE [Image 2] and again has a higher than normal tin reading creating a tin bronze alloy that is tarnish resistant.

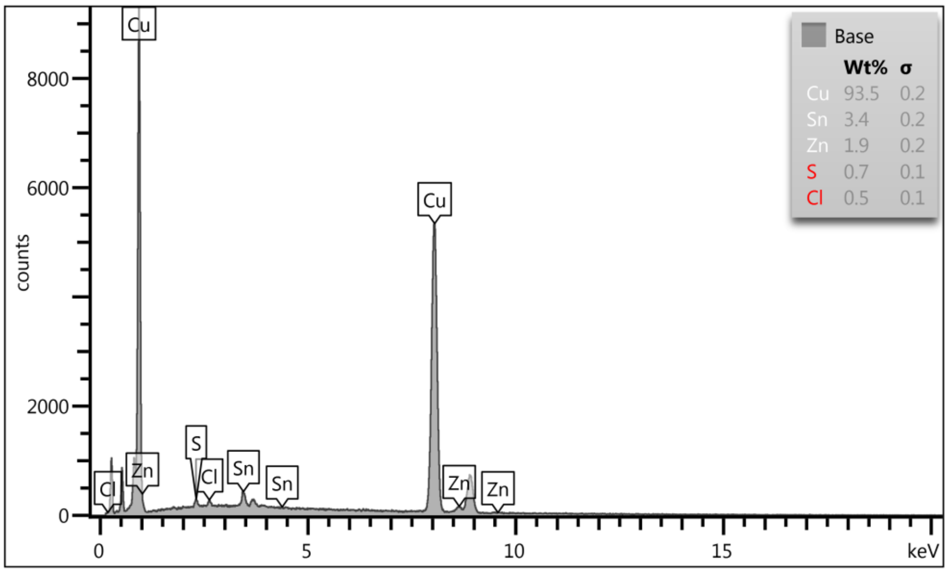


Image 1

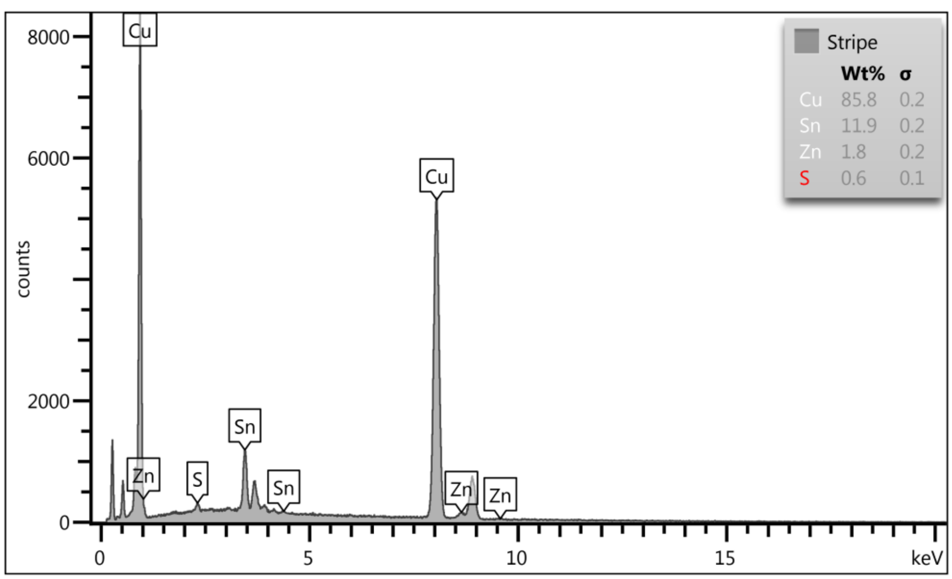


Image 2

Although these coins are categorized as Woodies they are not an improper alloy mix as the metal has fallen onto the surface of the rolled stock and been pressed into the surface of the planchet before entering the striking chamber.

Chapter 8

Resulting Side Effects

There are multiple errors caused by side effects of improper alloy mixes. These can be identified as lamination crack, lamination peel, detached lamination peel, split clamshell, detached clamshell, and split planchet. These errors are not exclusively caused by improper alloy mixes but may also be caused by contamination from water, grease, and dirt.

LAMINATION CRACK

LAMINATION PEEL

DETACHED LAMINATION PEEL

SPLIT CLAMSHELL

DETACHED CLAMSHELL

SPLIT PLANCHET

Chapter 9

A World of Woodgrain Coins

In a numismatic world of wonders there will always be something to explore and research. Woodgrain coins are no exceptions. Every coin from the half penny to the dollar can be sought out for these errors, some easier than others. Here is a small sampling of what can be found....


GEORGIVS V DEI GRA: REX ET IND: IMP:


1863


HALF PENNY
1959


UNITED STATES OF AMERICA
1905


IN GOD WE TRUST
LIBERTY
1910

E PLURIBUS UNUM
ONE CENT
UNITED STATES OF AMERICA


IN GOD WE TRUST
LIBERTY

IN GOD WE TRUST
LIBERTY
1920


IN GOD WE TRUST
LIBERTY
1937


ONE
CENT


IN GOD WE TRUST
LIBERTY
1944
E PLURIBUS UNUM
P
MONTICELLO
FIVE CENTS
UNITED STATES OF AMERICA


IN GOD WE TRUST
LIBERTY
1945
E PLURIBUS UNUM
P
MONTICELLO
FIVE CENTS
UNITED STATES OF AMERICA


E PLURIBUS UNUM
ONE
CENT
UNITED STATES
OF AMERICA


IN GOD WE TRUST
LIBERTY
1919


UNITED STATES OF AMERICA
1887


ONE
CENT


IN GOD WE TRUST
LIBERTY
1954
S


E PLURIBUS UNUM
ONE
CENT
UNITED STATES
OF AMERICA


ONE
CENT
CANADA
1915


UNITED STATES OF AMERICA
2
CENTS

Conclusion

Researching and understanding the why and how mint errors occur should be on the mind of any collector whether a beginner or a novice. Knowing the process in which the error is created, intentional or by mistake, is the intrigue each collector should possess. Like anything collectable in the numismatic world, fads come and go. These once discarded and underappreciated mint errors have, for the time being, begun to be popular and take collectors young and old to enter….

……..***The Rabbit Hole***.